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## ABSTRACT

In a review of research on computer assisted instruction (CAI) related to reading, evidence collected provides tentative conclusions about CAI effectiveness. CAI was effective as an instructional medium in the surveyed studies. In a number of instances, CAI groups achieved higher scores than the control groups. Some studies indicated that CAI appeared to work more effectively for slower, disadvantaged, and below-grade-level readers than for average or above-average readers. CAI clearly achieved higher results with deaf students. According to the results reported, CAI can be used equally well in teaching various reading skills and strands. The rapidity of computer development and use, however, somewhat limits the value of this information. Additionally, possibilities and questions are being created by research in the field of artificial intelligence (AI). Attributing the narrow range of current classroom computer application to the computer's inability to interact with students, one researcher maintains that until AI research produces computers which more closely simulate human cognitive processes, the instructional applications of computers will be severely limited. At this time in CAI history, it is safe to say that CAI is a viable supplement to traditional reading-instructional practices; and the future is promising. (Six tables of data are included, and 78 references are attached.) (MG)

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The Relative Effectiveness of Computer Assisted  
Instruction (CAI) for Teaching Students to Read English

Thirteenth World Congress on Reading  
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by

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# THE RELATIVE EFFECTIVENESS OF COMPUTER ASSISTED INSTRUCTION (CAI) FOR TEACHING STUDENTS TO READ IN ENGLISH

## Introduction

Computers are relatively new classroom invaders, and they have aroused intensive interest. A school hardly exists which does not have at least one these technological marvels, and many have fully networked computer classrooms. Although Computer Assisted Instruction (CAI) began in reading with drill and practice formats, the scope quickly extended to tutorial modes. And it was these programs which initiated many teachers and students into the wonderful world of computers. However, the marvels continually unfold in a likely never-ending-process. A recent milestone in computer development, which has profound implications for educators and students, is the optical disc. A single optical disc holds complete sets of encyclopedia. The advances in computer technology has barely begun. In fact, Stephen (1988) considers the state of educational technology race as just the beginning. The reality of what computers can do today must have been uncomtemplated a decade ago when microcomputers were introduced to the education world. Most likely few, if any, can envision what educational computer technology holds for the 21st Century.

Telling all about computers is beyond the scope of this report. CAI effectiveness in the classroom is a concern, and its efficacy for reading instruction must be a consideration for reading teachers. Therefore, whether CAI is effective in teaching reading is the purpose of this report. The findings might be helpful to decision-makers as to whether schools should allocate extensive funding for computers and their courseware from meager resources. In an effort to provide information to teachers for making decisions on the relative value of CAI for reading instruction, a review of empirical investigations seems appropriate. Thus, the scope of this report is narrowed and focused on the following questions.

The first logical question to be answered is whether computer-assisted reading instruction is effective? Roblyer and King (1983) reported on computer-based reading instruction applying a meta-analysis statistical procedure to several small studies. These researchers concluded that CAI reading instruction was beneficial. However, Marsh (1983) came to the opposite conclusion reporting that CAI reading studies were not in agreement. The time lapse since these contradictory conclusions has provided additional investigators to present newer findings, and Rauch (1986) ... asks educators to remain skeptical in face of the public's willingness to believe without question CAI publicists' and proponents' claims that "newer" is better where reading programs are concerned. Also, Blair, Rupley, and Jones (1986) state, "Only when instructional outcomes of microcomputers are adequately assessed can external validity be established for their efficacy in teaching reading." Yet, Balajthy (1987) insists that there is no doubt that computer instruction is effective. The debate must continue.

To investigate these questions, a search of the literature was made. Principal data bases for this project were Dissertation Abstracts, British Education Index, USA Education Index, and Education Resources in Education (ERIC).

The relative value of this new electronic medium deserves continual monitoring, and that is the purpose of this report. The central questions addressed in this report are:

1. CAN COMPUTER-ASSISTED INSTRUCTION HAVE A POSITIVE EFFECT ON READING ACHIEVEMENT.
2. IS CAI MORE EFFECTIVE THAN TRADITIONAL TEACHER-DIRECTED INSTRUCTION?
3. WHICH READING SKILLS OR STRANDS ARE BEST TAUGHT BY THE COMPUTER.

#### Comparative Studies

Although many articles have been written about CAI, fewer controlled reading studies dealing with CAI effectiveness have been reported. These studies are diverse in several ways, and for purposes of organization, these studies are grouped into categories of Generalized Reading Achievement, Phonics, Comprehension, and Exceptional Students' Reading Achievement. Hopefully the arranging of these studies chronologically from oldest to most recent enhances the organization and aids the reader.

#### Generalized Reading Achievement

In 1972, Vinsonhaler and Bass reported "A Summary of Ten Major Studies on CAI Drill and Practice." These ten studies were across the disciplines of mathematics (7) and language arts (3). Vinsonhaler and Bass concluded that in the field of elementary education there appears to be little reason to doubt that CAI plus traditional classroom instruction is usually more effective than traditional instruction alone in developing skills, at least during the first year or two.

Caldwell (1973) investigated the effect of CAI reading instruction and programmed reading instruction upon 14-18 year olds reading below fifth grade level. Both groups were given an occupational information reading program as content with one group receiving CAI and the other programmed reading. Both groups achieved at a significantly higher level as determined by pre- and post-tests but the conclusion was that self-instructional programs in programmed texts and under computer control can be used effectively to individualize the teaching of reading, but there is no significant advantage for CAI.

Working in Ft. Worth, Texas, Lysiak, Wallace and Evans (1976) reported significant vocabulary and reading gains for grades 3, 6, and 7 but not in grades 4 and 5 when those students were given CAI instruction. These mixed results were inexplicable.

Litman's (1977) study at the University of Northern Illinois involved teaching intermediate grade students reading with a CAI drill and practice mode. Analysis revealed that the experimental fourth and

fifth graders scored higher on the reading achievement test at the end of the year of instruction than did non-CAI participants; however, for sixth graders, CAI drill and practice reading instruction appeared to be no more effective than non-CAI instruction. Mixed results?

In the PLATO Elementary Reading Curriculum (PERC) experiment at the University of Illinois, Yeager (1977) reported that twenty-five classrooms were used. These classes were mostly first grades but included some kindergartens, second grades, and remedial reading classes. PERC was to develop instruction which could be used independently at the terminal without the need for an instructor, but PERC found this goal illusive. Yeager (1977) stated that the experience in the classroom proved again that any new innovation has to be integrated into the existing classroom structure. From that conclusion, PERC has been redirected to move into a complementary classroom role.

Yeager was reinforcing the notion that the computer cannot replace the teacher. The attempt to have the computer provide independent beginning reading skill instruction resulted in inadequate coverage. Also, many lessons were unsuitable for presentation by the computer. As Yeager (1977, p.13) says, "... they would be done better by a teacher or by some other medium." He is supported by Swinton, Amarel and Morgan (1978) who cautioned that PLATO demonstrated negative impact on first grade reading achievement in the first semester of the demonstration year. Which technology to use for the most effective learning is a decision that all teachers should be equipped to make.

Anelli (1977) studied third and fourth grade CAI users. Girls at all levels showed the most progress in the CAI program, but the comparison between CAI users and non-users revealed no significant advantage for CAI. It was also found that students became less enthusiastic toward CAI after seven or eight hours of accumulated machine time.

Mravetz (1980) investigated CAI reading instruction with thirty rural, Caucasian, junior high school students. These students were reading a year or more below grade level. Reading achievement gained by the CAI group was statistically significant.

Levy (1982) sought to determine differences between three methods of instruction in reading: traditional, computer-assisted and prescriptive upon elementary students. No differences were found between the traditional and computer-assisted methods in reading comprehension or the prescriptive and computer-assisted methods in increasing achievement in comprehension, vocabulary or total reading.

A Portland, Oregon Public Schools study (1982) showed non-significant gains in two areas where CAI was used. This report recommended that a concerted effort be made to discover if and how CAI can be effectively and efficiently used before it is widely funded.

Kester (1982), in a study assessing the economic viability of CAI in basic skills instruction for black, disadvantaged community college students, found a significant gain in basic skills through the use of

CAI to supplement their regular programs. The report questions whether certain types of students benefit more from CAI than others.

Schmidt's (1986) quasi-experimental study was designed to investigate the effects of CAI on the reading achievement of 122 junior high school students in Eastern Pennsylvania. The results indicated no significant difference between the control and experimental groups.

Sixth and seventh graders from rural, lower socioeconomic backgrounds were divided into equal groups of size and sex, by grade, to create two experimental and two control groups by Merritt (1982). CAI was contrasted with conventional teaching. Gains in reading achievement were significantly higher in those groups provided with CAI.

Roberts (1982) used subjects from grades 3 through 6 to ascertain the effectiveness of reading instruction supplemented with CAI. No significant difference was found.

Significant gains in both learning rates and performance were reported by Weaver (1982) in a study involving poor readers at the secondary school level. A training program in the form of a computer based game was used to teach reading analysis skills. Subsequent testing revealed that students were able to transfer skills learned to other reading components.

Fifteen elementary school boys with reading disabilities were broken into three different groups according to specific skill deficits and given CAI. Fiedorowicz (1983) reported the CAI training proved beneficial in improving students' reading skills and increasing their word recognition achievement.

Chapter 1 students in grades, 4, 5, and 6 were the subjects of a study by Ortmann (1983) to determine the effectiveness of CAI in improving reading achievement. It was found that CAI supplementation in reading instruction may be effective in improving achievement.

Porinchak (1983) designed a study for secondary students to evaluate various aspects of CAI, including its impact on reading achievement. Students were placed in either average or below average groups. The students preferred CAI as the mode of instruction, but traditional methods were equally effective compared to CAI.

Hoffman (1984) used fifth graders in a CAI study. Results were mixed indicating that CAI was more effective for males than for females. Females fared better in vocabulary and comprehension when supplemented with traditional instruction, while males supplemented by CAI performed better than males supplemented by traditional instruction.

Merrill (1984) divided third, fourth and fifth graders into three groups and gave various levels of CAI to test effects of CAI in reading and math. Group I received direct instruction using CAI; Group II had some experience with CAI; and group III had none. Supplementation of traditional instruction with CAI improved academic gain in math but not in reading.

In a study comparing the use of the Language Experience Approach (LEA) approach with and without CAI, Casey (1984) found beginning reading instruction to be enhanced by the use of a computer with a voice synthesizer and special software.

The purpose of William's (1984) study in North Texas was to determine the effectiveness of CAI on math and reading achievement and learning style elements. Fourth graders were the subjects and they were exposed to 15 minutes of CAI per day in reading and math. It was concluded that controls achieved higher than experimentals using CAI.

The purpose of Coomes' (1985) study was to determine the effectiveness of microcomputer usage in supplemental reading and language instruction. Fifty-one matched pairs of Texan fourth graders were the subjects for this research. The author concluded that using prescribed software for thirty minutes a week did not significantly improve total reading or total language scores on The Comprehensive Tests of Basic Skills.

Reitsma (1988) attempted to determine which of three ways of practicing reading most effectively facilitates the development of efficient reading skills in beginners: guided reading, reading-while-listening, or independent reading with computer-generated speech feedback available for students to use at will. The subjects were seventy-two first grade students in three experimental conditions and a control condition who read a text passage for five consecutive days. With the exception of the control group, the five texts repeated 20 target words that were relatively hard for beginner readers. Students were then tested on the 20 words before and after treatment then analyzed for changes in rate and accuracy. The results suggest that both guided reading and independent reading with self selected speech feedback were found to be significantly more effective than the control and reading-while-listening conditions. These findings indicate that increases in reading efficiency depend on the amount of independent, self-propelled reading activity of the reader. If an independent activity such as this is included, then computer-assisted practice with speech feedback appears to be an effective method of improving the skills of beginner readers.

Lore and Chamberlain (1987) evaluated the Secondary Developmental Reading Program to determine its effectiveness in assisting underachieving high school pupils improve their reading and communication skills. The subjects were 809 ninth and tenth grade students from thirteen high schools. Individual instruction was provided in small group settings, some program sites used CAI in addition to the individual instruction. The results indicate that computer users scored no better than other groups on the achievement criterion as measured on The Comprehensive Tests of Basic Skills.

A study examined two ninth grade classes (15 students per class) to determine what differences, if any, were present after remediation of the experimental samples deficiencies with CAI (Marcinkiewicz, 1988). The control sample received direct instruction in a classroom setting for five 43 minute periods per week, while the experimental

samples received three 43 minute periods of direct instruction, plus CAI for two 43- minute periods per week! The results indicated that there were no significant differences between the experimental and control groups.

Chamberlain (1987) conducted a cost benefit study to determine the effectiveness of a computer-assisted instruction/computer management system (CAI/CMS) as an alternative to conventional methods of teaching reading in Columbus (Ohio). Results indicate that the CAI/CMS groups surpassed the regular group in achievement level at the middle school level and, while a negative change occurred at the high school level. Findings also indicated that CAI/CMS teachers served more pupils per teacher than did regular program teachers and that CAI/CMS pupils surpassed regular program pupils in attendance at all levels.

The Compensatory Language Experiences and Reading Program (CLEAR) was implemented to assist underachieving students in grades one through eight (Lore & Chamberlain, 1987). The program included individual and small group instruction according to pupil needs and also provided microcomputers to some of the pilot program for students in grades four through eight. The results indicated that average Normal Curve Equivalent (NCE) gains for students using Computer Assisted Instruction were higher for those than for the regular group at both the elementary and middle school levels.

Recent research (Mys & Petrie, 1988) was made in Dearborn, Michigan of students in grades two, three and four, who had received regular reading instruction through the World Institute of Computer Assisted Teaching (WICAT) system. Results indicated that students who had received WICAT instruction had made significant gains in math and reading. The percentage of grade four students mastering reading skills increased from an average of 42.2 per-WICAT to 51.2 post-WICAT. Later testing revealed that 60.5% had attained mastery.

Another study (Clariana and Schultz, 1988) in Tennessee, using the WICAT system showed that increases in ITBS scores were significant. The average gain for all subjects (10 students in each of grades four through eight) during the two years before WICAT was 0.85 grade equivalents (G.Eq.) per year. The average gain for all for the two years until WICAT was 1.17 G.Eq per year. (National norm is 1.00). After grouping high and low ability students, the high ability group showed an average pre-WICAT gain of 0.97 G.Eq. per year, an average post-WICAT gain of 1.15 G.Eq. per year. These results suggest that the WICAT CAI was beneficial for all students, but was particularly effective for students below the median.

#### Writing to Read

International Business Machines (IBM) promotes John Henry Martin's Writing to Read (1984) program which is designed to help teach kindergarteners and first graders how to write anything they can say and read anything they can write. The equipment costs about \$50,000 per classroom (Vernot, 1987). Writing to Read (WTR) uses an IBM PC Jr. equipped with a digitalized voice attachment card that enables the computer to introduce the 42 individual phonetic sounds of the alphabet. This program builds on students' natural language

development providing a logical sequential and consistent format that allows students to translate their spoken language into words they can read. WTR teaches children that what they can say, they can write, that what they can write they can read. Although relatively new, WTR has been investigated.

A multi-site study of WTR conducted for IBM by Educational Testing Service and reported by Murphy & Appel (1984) showed significantly higher rates of learning and achievement for students using the system when compared to students not using the system. The study involved kindergarten and first grade students using a multi-media program incorporating IBM microcomputers, cassette tapes and printed materials. While reported gains were highest for writing skills, the study noted that in reading, kindergarten WTR students had a significant advantage over comparison students, but Grade 1 WTR students did not exceed the controls.

Table 1

The ETS Evaluation of Writing to Read on Kindergarten & First Graders (1984, p.9)

| Kindergarten Populations with Pre-and Post-Reading Measures |                                   |                           |
|-------------------------------------------------------------|-----------------------------------|---------------------------|
| Population                                                  | Number of Writing to Read Schools | Effect of Writing to Read |
| A. Basic Populations                                        |                                   |                           |
| 54                                                          | 6                                 | Positive                  |
| 55                                                          | 1                                 | Positive                  |
| 56                                                          | 2                                 | Positive                  |
| 60                                                          | 4                                 | Positive                  |
| 62                                                          | 1                                 | Positive                  |
| B. Special Populations                                      |                                   |                           |
| 51                                                          | 1                                 | Equal                     |
| 53                                                          | 1                                 | Equal                     |
| 59                                                          | 1                                 | Equal                     |
| C. New Participants                                         |                                   |                           |
| 63                                                          | 2                                 | Positive                  |
| 64                                                          | 5                                 | Equal                     |
| 65                                                          | 4                                 | Positive                  |

| First Grade Populations with Pre- and Post-Reading Measures |                                   |                           |
|-------------------------------------------------------------|-----------------------------------|---------------------------|
| Population                                                  | Number of Writing to Read Schools | Effect of Writing to Read |
| A. Basic Populations                                        |                                   |                           |
| 52                                                          | 1                                 | Equal                     |
| B. Special Populations                                      |                                   |                           |
| 59                                                          | 1                                 | Equal                     |
| C. New Participants                                         |                                   |                           |
| 63                                                          | 2                                 | Equal                     |
| 65A                                                         | 4                                 | Equal                     |
| 65B                                                         | 4                                 | Equal                     |

McDowell (1986) conducted a three year study in Raleigh, North Carolina designed to determine what effect WTR had on the students who began the program as kindergarten students. The results indicated that WTR had a positive effect on students' reading, writing and spelling skills.

T.E. Thompson (1985) studied the effectiveness of WTR on a sample of nine and ten year old students who were at least one-half year below grade level. The results indicated that WTR could increase vocabulary and total reading scores at a highly significant level when compared to the scores of the control group. There were no significant differences between comprehension pre and posttest scores for either the experimental or the control group.

As one aspect of a larger study in Dallas-Ft. Worth, Schneider (1985) examined the contribution of I.Q. and gender as variable predictors of reading achievement in a CAI setting. The sample was comprised of 2,000 third and fifth grade students. High and low third grade boys and girls benefitted equally from CAI. In fifth grade, low IQ students showed more gain in reading achievement using CAI than those with high I.Q. Fifth grade girls gained more than boys from CAI. Other instructional strategies for high I.Q. fifth graders would be more appropriate. Overall, the results were mixed.

Kochinski (1986), examined the effects of CAI on reading achievement of (40) Pittsburgh middle school students enrolled in a Chapter I program. The author concluded that there were no statistically significant difference between students using CAI and those using more traditional methods of reading remediation. Interestingly, students selected CAI as the preferred method of instruction, but they felt traditional methods were more effective in teaching students.

Brierley (1987) evaluated two nontraditional kindergarten programs and evaluated the programs to determine their success. One program featured a full day kindergarten that provided opportunities for personal and social development in addition to the standard curriculum. The second program included interactive experiences with microcomputers and the WTR program. Children were divided into four groups: a control half-day kindergarten group, a full-day group, a half-day WTR group and a full-day WTR group. The results indicate higher achievement in language and reading achievement as determined by the Metropolitan Achievement Test and for these students in full-day K and WTR programs as well as better adjustment to school in the WTR classrooms. Table 1 represents the ETS evaluation of WTR (Murphy & Appel, 1984, p. 9).

With limited research the WTR material seems to work as well as traditional strategies for reading development and appears to facilitate children's writing development a little better than the controls. Writing to Read is a usable program for initial reading instruction in kindergarten or first grade; however, the investment cost is significant and cost effectiveness is a consideration.

Generalized CAI reading achievement results are grouped in Table 2

Table 2

CAI Versus Controls for Generalized Reading Achievement

| YEAR | INVESTIGATORS             | LEVEL               | RESULTS  |
|------|---------------------------|---------------------|----------|
| 1972 | Vinsonhaler & Bass        | Elem. Lang. Arts    | CAI      |
| 1973 | Caldwell                  | Secondary           | Equal    |
| 1976 | Lysiak, Wallace & Evans   | 3rd - 7th           | Mixed    |
| 1977 | Litman                    | 4th, 5th, 6th       | Mixed    |
| 1977 | Anelli                    | 3rd and 4th         | Equal    |
| 1978 | Yeager (PLATO),           | K - 2               | Controls |
| 1980 | Mavretz                   | Jr. High Remedial   | CAI      |
| 1982 | Levy                      | Elementary          | Equal    |
| 1982 | Portland Public Schools   | Elementary          | Equal    |
| 1982 | Kester                    | Comm. College       | CAI      |
| 1982 | Merritt                   | 6th & 7th           | CAI      |
| 1982 | Roberts                   | 3rd-6th             | Equal    |
| 1982 | Weaver                    | Secondary           | CAI      |
| 1983 | Fiedorowicz               | Elem. Rdg. Disabled | CAI      |
| 1983 | Noda                      | Middle School       | Equal    |
| 1983 | Ortman                    | 4th, 5th, 6th       | CAI      |
| 1983 | Porinchak                 | Secondary           | Equal    |
| 1984 | Hoffman                   | Fifth               | Mixed    |
| 1984 | Merrell                   | 3rd-5th             | Equal    |
| 1984 | Casey                     | 1st                 | CAI      |
| 1984 | Murphy & Appel (ETS, IBM) | Elementary          | CAI      |
| 1984 | Williams                  | 4th                 | Controls |
| 1985 | Coomes                    | 4th                 | Equal    |
| 1985 | Thompson, T.E.            | 3rd & 4th           | Equal    |
| 1985 | Schneider                 | 3rd & 5th           | Mixed    |
| 1986 | Kochinski                 | Middle School       | Equal    |
| 1986 | Schmidt                   | Jr. High            | Equal    |
| 1986 | McDowell                  | Elementary          | CAI      |
| 1987 | Chamberlain               | K-High School       | Mixed    |
| 1987 | Brierley                  | Kindergarten        | CAI      |
| 1987 | Lore & Chamberlain        | Secondary           | Equal    |
| 1988 | Clariana and Schultz      | 4-8                 | CAI      |
| 1988 | Reitsma                   | 1st                 | CAI      |
| 1988 | Marcinkiewicz             | 9th                 | Equal    |
| 1988 | Mys and Petrie            | 2-4                 | CAI      |
| 1989 | Lore & Chamberlain        | 1-8                 | CAI      |

Summary Generalized Reading Achievement

CAI appeared to be effective in 30 of 36 cases (83%) reported. Only three studies seemed to have favored the controls.

In 15 of 36 cases (42%), CAI appeared to achieve superior generalized reading achievement in comparison to the controls, with the controls achieving higher than experimental CAI groups in only two studies (6%). For overall reading achievement, CAI seemed to have demonstrated superior achievement to traditional instruction.

### Phonics Achievement

Atkinson and Fletcher (1972) reported results of the three-year CAI reading study which focused on teaching decoding skills. Fifty pairs of kindergarten students were matched on a number of variables and the findings revealed the E Group had a 5.05 month gain over the control. Tested a year later with no CAI treatment given in the intervening time, the difference in favor of the E group of 4.90 months.

Wisher (1980) taught phonics to twenty-four U.S. Navy recruits. He utilized experimental and control groups. The experimental group was presented a multi-media system of instruction consisting of a minicomputer, viewing consoles, response entry keyboards and a voice synthesizer. Results did not favor either group.

Roth and Beck (1984) used a CAI program to enhance decoding skills of elementary children whose reading abilities were below grade level. The CAI program increased the pupil decoding skills.

First-grade students receiving traditional instruction in phonics and mathematics were compared with first-grade students receiving CAI in a study by Abram in 1984. Half of the group of 103, males and females, was assigned to receive CAI in phonics and the other half received CAI in mathematics. The groups served as controls for each other. No significant differences were observed between groups in phonics achievement.

Elliott's (1985) study explored the effects of CAI upon the reading proficiencies of secondary vocation educator students in Michigan. The results indicate that there was not a significant difference between the experimental and control groups in reading scores.

The purpose of McCormack's (1985) Colorado study was to determine if CAI was an effective way to teach letter-sound relationships to kindergarten students. The results indicated that the experimental groups scored significantly higher on the letter-sound criterion test and significantly higher on The Stanford Early School Achievement Test. The author concluded that the teaching of letter-sound relationships by CAI has significant effects on the acquisition of letter-sound relationship skills.

Investigators studied the effectiveness of two microcomputer programs for improving word recognition/decoding skills while examining the extent to which decoding improvements lead to improvements in reading comprehension (Roth & Beck, 1987). The subjects were three fourth grade classes whose students were from low socioeconomic backgrounds with a history of low reading achievement. Performance was then measured by standard achievement tests and laboratory tasks. The results indicate that use of the programs led to (a) substantial increases in word recognition/decoding skills, and (b) sentence level, but no improvement at the passage level.

Table 3 highlights studies related to phonics achievement.

Table 3

CAI Versus Controls for Phonics Skills Achievement

| YEAR | INVESTIGATORS       | LEVEL        | RESULTS |
|------|---------------------|--------------|---------|
| 1972 | Atkinson & Fletcher | Kindergarten | CAI     |
| 1980 | Wisher              | Adults       | Mixed   |
| 1984 | Roth & Beck         | Elementary   | CAI     |
| 1984 | Abram               | 1st - 6th    | Equal   |
| 1985 | McCormack           | Kindergarten | CAI     |
| 1985 | Elliott             | Secondary    | Equal   |
| 1987 | Roth & Beck         | 4th          | Mixed   |

Summary Phonics Achievement

The seven studies reported on CAI phonics achievement reveal that CAI in an effective teaching procedure for sound/symbol relationships. Three of seven studies reported results favoring CAI over traditional teaching strategies.

Comprehension

(The total reading comprehension were reported earlier in Levy's (1982) study under Generalized Reading Achievement). The effect of CAI on comprehension development was compared to traditional methods. No significant difference was found.

In a study to measure the effects of classroom instruction supplemented with CAI, Easterling (1982) used 66 fifth graders as subjects. Results suggested that using CAI supplements did not improve reading comprehension to any significant degree.

Alessi, Siegel, Silver and Barnes (1983) conducted an experiment with thirty-six adults at Sheridan Illinois Correctional Center. The students were involved in either CAI reading or math lessons for about two months. The results showed that students who studied the reading comprehension subskills of "information findings" and "paraphrasing" improved markedly and retained their skill improvement after more than a month. Control students showed no change.

Computer-automated reading to develop word recognition skills of first and second graders was evaluated by Leton & Pertz (1984). The experimental groups received automated reading with their instruction. Pre and post testing revealed no significant advantage for CAI, that traditional instruction was as effective as CAI.

Fifth graders in Seminole County, Florida were involved in a CAI reading comprehension study. The experimental group used a tutorial program of interpretive comprehension skills. Each student used the computer for approximately five hours of CAI time. Midgett, Thompson and Walters, (1985) reported the results were not significantly different between control and experimental subjects.

Enoch (1984) investigated the relationship of learning style, reading vocabulary, reading comprehension and learning aptitude in both its self-paced and computer assisted instructional modes at the Naval Yeoman's School. Significantly higher achievement was indicated for the sailors in the CAI intervention group.

Bassett's (1985) study investigated the efficiency of the computer in teaching reading, as well as the effects of chunking text, or breaking it into meaningful units, on the subjects' comprehension of the text. Thirty remedial, intermediate grade students participated in this study. The results revealed that neither reading material on the computer nor chunking the material into meaningful units enhances or impairs comprehension or reading rate.

Todd (1985) treated fourth graders with CAI instruction to determine whether CAI was more effective than traditional reading instruction. Todd's results indicate that those students in a traditional reading program made gains higher than the CAI students.

The effectiveness of CAI with handicapped and low ability students has also long been a controversial issue. Some have suggested that CAI for the handicapped is where CAI can be best utilized. Motivated by a lack of research in this area, Harper & Ewing (1986) conducted a study on nine special education students (age range 11.5-13.5) to compare the effectiveness of microcomputers and workbook instruction on silent reading comprehension performance. Their findings revealed that for 8 of these 9 students, the microcomputer was the most effective treatment in terms of productivity, meaning, the number of comprehension questions answered correctly. For one student, only, the workbook was the most effective treatment in terms of reading comprehension productivity.

Research by Gambrell (1987) revealed that third and sixth grade students showed no differences in reading comprehension from the page or from the computer screen. But, the students were more interested in the story while reading from the screen even though the story was more difficult in the condition.

On the other hand, Kinzer, Sherwood, & Loofbourrow (1989), when comparing retention of popular science material by fifth grade students found a statistically superiority in favor of use of expository text over the use of computer simulation software. See Table 4 for a summarization of the results of the comprehension CAI studies.

Table 4  
CAI Versus Controls for Comprehension Achievement

| YEAR | INVESTIGATORS                 | LEVEL           | RESULTS     |
|------|-------------------------------|-----------------|-------------|
| 1982 | Levy                          |                 | Equal       |
| 1982 | Easterling                    | 5th             | Equal       |
| 1983 | Alessi, Siegel & Silver       | Adult Prisoners | CAI         |
| 1984 | Leton & Pertz                 | 1st & 2nd       | CAI         |
| 1984 | Midgett & Thompson            | 5th             | Equal       |
| 1984 | Enoch                         | Adult           | CAI         |
| 1985 | Bassett                       | 4th - 6th       | Equal       |
| 1985 | Todd                          | 4th             | Controls    |
| 1986 | Harper & Ewing                | Special Ed.     | CAI         |
| 1987 | Gambrell                      | 3rd and 6th     | Equal (CAI) |
| 1989 | Kinzer, Sherwood, Loofbourrow | 5th             | Controls    |

Summary Comprehension Achievement

The results of the above studies indicate that CAI training is effective in teaching reading comprehension skills and that it might be more effective than traditional methods. In all CAI comprehension studies, students learned using CAI. In four of the eight cases, CAI groups outperformed their controls, while only two control groups performed better than CAI comparative groups.

Exceptional Students

One of the most significant developments in education within the last decade has been the availability of computer technology for everyday instructional use in the classroom (Harper, 1985). Several researchers have suggested that CAI might be more effective than traditional methods with low ability and handicapped students (Bennet & Maher, 1984; Harper, 1985; Jones, Forgesen, and Sexton, 1987). With this perspective, studies in this section were highlighted which specifically related to exceptional students. For convenience and clarity, the studies have been grouped into subsections: Learning Disabled and Deaf Handicapped.

Learning Disabled

Abegylen (1984) examined the application of CAI towards the improvement of mathematics and reading test scores of educationally handicapped high school students. The sample consisted of students in Memphis, Tennessee receiving CAI from one to four years. Although no control group was used, it was concluded that CAI was feasible for use with educationally handicapped high school students and that it may be useful in improving test scores.

Nine junior high school learning disabled and educable mentally handicapped students were investigated by Harper (1985). The study was designed to compare the effectiveness of CAI and workbook instruction on reading comprehension. With

alternating workbook and computer instruction for 20 minutes a day over a four-week period, the researcher found that for 8 of the 9 students, the CAI was the most effective treatment.

Learning disabled students in grades 9 - 12 were subjects in a study by Keene (1985) to determine whether the computer or text material was more effective in aiding students' comprehension development. Subjects (51) were randomly assigned to two groups. The results favored neither group.

Nine LD students, whose reading level was at least one year below age level, participated in a study by Van Den Meiracker (1986). Four subjects were characterized as having normal patterns of classroom behavior, while the other five displayed maladaptive patterns of behavior. Two treatments were given. Teacher based instruction and computer based instruction were the two treatments given for reading comprehension development. Results indicated that reading comprehension under teacher based conditions was the same for the two subgroups; however, reading comprehension performance under computer-based conditions was a function of subtype-membership.

Students with maladaptive behavior showed lower performance levels using CAI than under the teacher-based condition. LD students with normal patterns of behavior performed equally well under both conditions. As far as reading comprehension achievement is concerned, the CAI instruction was not any more effective than teacher directed instruction.

Increasing decoding fluency in LD children was the topic of investigation for Jones, Torgensen and Sexton (1987). They involved students in using a program which focused on teaching the recognition of words containing medial vowels and combinations. The controls used a spelling computer program. The 20 LD children were paired for treatment comparison purposes. The results indicated that the experimental group improved substantially in both reading speed and accuracy of work reading as a result of practice with the CAI program.

The four studies reported for learning disabled students taken together reveal mixed results. These studies are depicted in Table 5.

Table 5

CAI VERSUS CONTROLS FOR READING ACHIEVEMENT OF LD STUDENTS

| Investigation                      | Students                          | Area          | Results  |
|------------------------------------|-----------------------------------|---------------|----------|
| 1985 Harper, J.A.                  | J.H.S.                            | Comprehension | CAI      |
| 1985 Keense, S.W.                  | S.H.S.                            | Comprehension | Equal    |
| 1986 Van Den Meiracker             | Elementary                        | Comprehension | Equal    |
| 1987 Jones, K.M;                   | Elementary                        | Vowel Sounds  | CAI      |
| Torgensen, J.K. &<br>Section, M.A. |                                   |               |          |
| 1987 Wright, A;                    | Severely                          | initial sight | Controls |
| Anderson, M.                       | Learning<br>Disabled<br>Ages 4-18 | Vocabulary    |          |

The results are difficult to generalize. There is no clearcut advantage in the results with CAI holding the advantage in two studies, the controls ahead in one, and two ties. Numerically there is a slight advantage favoring CAI, but it is really more of a tossup. What is bothersome is the limited number of subjects in these studies (nine, fifty-one, nine, twenty, and eighteen). Application of parametric statistics to such small populations seems of dubious value in most cases. Therefore, the investigators' and readers' conclusions must be considered risky.

#### Deaf Students' Reading Achievement

At Stanford University, Atkinson, Fletcher and Suppes (Fletcher & Suppes, 1973) (Fletcher, 1975), instructed deaf students in mathematics and language arts using CAI. Their aims were to demonstrate that CAI could be used to advantage by deaf students, that CAI could support serious research in deaf education, and that a favorable argument could be made for the economics of CAI. These researchers concluded that CAI can be used successfully by deaf students.

Later experiments involving the use of a microcomputer with deaf students have shown advancements made in the area of reading comprehension. Prinz, Nelson and Stedt (1982) employed computers with 3 to 6 year old students at the Pennsylvania School for the Deaf. The students made significant gains in word recognition and identification skills. Similar results were reported by Pollard and Shaw (1982) at the Texas School for the Deaf in working with high school students. The students increased their use of new words in composition and conversation. These results were directly attributable to the initiation of their reading comprehension program through the development of the student's vocabulary building skills.

CAI with deaf students appears to contribute to higher reading achievement.

Table 6 denotes the results of CAI with deaf students.

Table 6  
CAI Versus Controls for Reading Achievement with Deaf Students

| YEAR    | INVESTIGATORS         | STUDENTS                        | RESULTS |
|---------|-----------------------|---------------------------------|---------|
| 1973-75 | Fletcher & Suppes     | Deaf Students                   | CAI     |
| 1982    | Prinz, Nelson & Stedt | Deaf Students<br>(3-6 yr. olds) | CAI     |
| 1982    | Pollard & Shaw        | Deaf Students                   | CAI     |

#### Summary Exceptional Students

In essence, exceptional students seem to work well with CAI. In the case of deaf students, CAI seems to be advantageous in promoting higher reading achievement. LD students learned from CAI instruction, but the evidence does not support clearly that CAI was more effective than traditional instruction.

## Summary and Conclusions

The results of CAI studies related to reading are not as plentiful as one would like to formulate firm conclusions. Nevertheless, the evidence collected so far provides tentative conclusions about CAI effectiveness. Can computer assisted instruction have a positive effect on reading achievement? The answer is yes; CAI was effective as an instructional medium in the surveyed studies. However, whether CAI is more effective in teaching reading than traditional practices remains unanswered.

In a number of instances, CAI groups achieved higher than the controls. Some studies indicated that CAI appeared to work more effectively for slower, disadvantaged, and below grade level readers than for average or above average readers. CAI clearly achieved higher results with deaf students. However, there is legitimate concern about the novelty aspect of using computers for the first time, and the Hawthorne effect variable might be operating. More investigations will help clarify this point.

Which reading skills or strands are best taught by the computer? Apparently CAI can be used equally well in teaching various skills and strands, at least for those aspects that have been reported. Whether CAI is used to teach phonics, comprehension, or general reading achievement; it is effective.

The rapidity of computer development and use somewhat limits the value of the above information. Additionally, possibilities and questions are being created by research in the field of artificial intelligence. Attributing the narrow range of current classroom computer applications to the computer's inability to interact with students, Balajthy (1986) maintains that until AI research produces computers which more closely simulate human cognitive processes, the instructional applications of computers will be severely limited. At this particular moment in computer assisted instruction history, it is safe to say that CAI is a viable supplement to traditional reading instructional practices, and the future is promising. Optical discs and artificial intelligence will provide technological advances for classroom computer use in the current decade and into the 21st century.

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